

### **REMARKS**

Claims 1-18 are currently amended. Claims 1 and 12 are amended.

Support for the new claims may be found in the specification as originally filed, for example, in original claims 2 and 3 and at page 27.

Claim 1 is amended for clarity. Specifically, the term “pKa” is the negative value of the logarithm of the dissociation constant  $k_a$ . The amendment to claim 1 merely clarifies that the term “pKa” is not the dissociation constant  $k_a$ , but is correctly the negative value of the logarithm of the dissociation constant  $k_a$ .

#### **I. Formal Matters - The Information Disclosure Statements**

The Examiner enclosed a copy of the PTO Form-1449. However, the Examiner did not indicate consideration by initialing next to the reference F. B. Kaufman et al.; Journal of the Electrochemical Society, Vol. 138, No. 11, pp.3460-3465, November 1991. The Examiner is requested to acknowledge consideration of the Kaufman journal article reference.

The Examiner has also not indicated receipt or consideration of the Information Disclosure Statement filed on March 16, 2007. The Examiner is requested to acknowledge receipt of the Information Disclosure Statement filed March 16, 2007 and initial and return a copy of the Form PTO/SB/08.

#### **II. The Rejection under 35 U.S.C. 112**

Claims 12-14 are rejected under 35 U.S.C. 112, second paragraph, as allegedly being indefinite.

The Examiner states that the wording used in claim 12 is confusing. The Examiner

particularly notes the references to the dented portions, and the projected portions.

Claim 12 has been amended for clarity and to more positively state the elements therein.  
See also pages 27-28 of Applicants' specification.

For the above reasons, it is respectfully submitted that Applicants' claims are clear and definite and it is requested that the rejection under 35 U.S.C. §112 be reconsidered and withdrawn.

**III. The Rejections Based on Kaufman et al.**

Claims 1-14 are rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Kaufman et al (US Patent 6,447,371).

Applicants respectfully submit that the present invention is not anticipated by or obvious over the disclosures of Kaufman et al '371 and request that the Examiner reconsider and withdraw this rejection in view of the following remarks.

The present application claims a polishing slurry with an acid in which the pKa of a first dissociable acid group is 3.5 or more, but still having a low pH and a low metal-oxidizing agent concentration region.

Kaufman et al '371 discloses a polishing method in two processes where two kinds of polishing slurries are used respectively. The second polishing slurry used in the second process of Kaufman et al polishes a barrier layer and thus may be compared to that of the present application. See, for example, Example 3 and TABLE 4 of Kaufman et al '371.

### **Organic acid**

The polishing slurry of the present application includes an acid in which the pKa of a first dissociable acid group is 3.5 or more. As a result, the polishing slurry provides a preferable property region, that is, the high polishing rate of the barrier layer (Ta) with the sufficiently reduced etching rate and polishing rate of the metal of the wiring portion (Cu) in range of pH 3-4 higher than the previous application. (See, for example, Applicants' Specification p 7, L 16 to p 8, L 4). Additionally, claim 3 recites the acid is an organic acid.

The present application recites an acid in which the pKa of a first dissociable acid group is 3.5 or more. Examples include lactic acid (3.66), succinic acid (4.00), adipic acid (4.26) and so on. (Specification p 13, L 3 to 21).

Kaufman et al '371 discloses many types of organic acids as complex agent in column 8, line 12-23, such as acetic acid (4.56) in claim 9, citric acid (2.87), lactic acid (3.66), tartaric acid (2.82), succinic acid (4.00), oxalic acid (1.01), amino acids and so on in claim 7. However, Kaufman et al '371 doesn't disclose the pKa range of a first dissociable acid group as in the present application. In addition, both of tartaric acid (2.82) and acetic acid (4.56) are used in Example. Therefore, Kaufman et al '371 discloses no description or suggestion or reason to select the organic acids by pKa of a first dissociable acid group.

### **pH**

Kaufman et al '371 discloses 2.0-12.0 of pH and preferably pH is 4-9. The present application claims pH within the range of 3 to 4. If the pH is more than 4, unexpectedly the

practical polishing rate of tantalums is not obtained because the pH comes off from the above-mentioned region of low pH and low metal-oxidizing agent concentration. (Specification p 14, L 5 to 15).

### **Concentration of metal-oxidizing agent**

The present application selects the concentration of metal-oxidizing agent such as  $H_2O_2$  within the range of 0.01-3 percent by weight (claim 1) and 0.01 to 1.5 percent by weight (claim 2). When the concentration is more than 3 percent by weight, unexpectedly the etching rate of metal such as Cu is increased, and the polishing rate of Ta also tends to be reduced (Specification p 12, L 12 to 23), owing to coming off from the above-mentioned region of low pH and low metal-oxidizing agent concentration.

### **Comparison**

One significant reason of such difference of preferable directions of the components in Kaufman et al '371 is the regulation of Kaufman et al '371 of "the weight ratio of oxidizing agent to complex agent is greater than about 10" (claim 1). Kaufman et al '371 obtains good polishing speed ratio by larger amount of oxidizing agent relatively than complex agent.

In the example of Kaufman et al '371 (Example 3 and TABLE 4, all of abrasive is fumed alumina),

Slurry 1  $H_2O_2$ /tartaric acid = 5%/0.5% = 10, no BTA, pH 7.0

Polishing speed ratio Cu:Ta = 1.9 : 1

Slurry 2  $H_2O_2$ / tartaric + acetic acid = 5%/0.4% = 125,

BTA 0.08% + urea 2%, pH 6.0, Cu:Ta = 1 : 1

Slurry 3 H<sub>2</sub>O<sub>2</sub>/acetic acid = 5%/0.2% = 2.5,

BTA 0.08% + surfactant 50ppm, pH 5.0, Cu:Ta = 1 : 4.5

All pH are more than 5, and the all weight ratio of the both are greater than about 10. Kaufman et al '371 indicates that such regulations provide preferable polishing speed ratio as the second CMP slurry, for example, Cu:Ta = 2:1(Ta/Cu>0.5), most preferably Cu:Ta = 1:5(Ta/Cu>5) (Column 7, L 25-31).

On the other hand, examples of the present application use 0.3wt% of H<sub>2</sub>O<sub>2</sub> (1wt% content of 30% H<sub>2</sub>O<sub>2</sub>, metal-oxidizing agent), 3.0wt% of colloidal silica having 70 nm of average diameter:

Example 1 H<sub>2</sub>O<sub>2</sub>/succinic acid = 0.3%/0.6% = 0.5, pH 3.13

Polishing speed ratio Cu:Ta = 1 : 2.8

Example 2 H<sub>2</sub>O<sub>2</sub>/lactic acid = 0.3%/0.05% = 6, pH 3.05

Polishing speed ratio Cu:Ta = 1 : 3.0

Example 3 H<sub>2</sub>O<sub>2</sub>/adipic acid = 0.3%/0.6% = 0.5, pH 3.23

Polishing speed ratio Cu:Ta = 1 : 3.0

Example 4 H<sub>2</sub>O<sub>2</sub>/glutaric acid = 0.3%/0.6% = 0.5, pH 3.18

Polishing speed ratio Cu:Ta = 1 : 2.8

Example 5 H<sub>2</sub>O<sub>2</sub>/glutaric acid = 0.3%/0.6% = 0.5, pH 3.55

Polishing speed ratio Cu:Ta = 1 : 2.4

All pH are 3-4. All weight ratio of the both are less than 10. Unexpectedly, excellent polishing characteristics were obtained in Examples 1 to 5. On the other hand, when the pH was more than 4 as in Comparative Examples 1 to 3, the polishing characteristics were inferior.

Therefore, the present application selects 3.5 or more of pKa of a first dissociable acid group of an acid, 3 to 4 of pH, and 0.01 to 3 percent by weight of metal-oxidizing agent, and by such a combination unexpectedly achieves improved property for Ta polishing system, that is, high polishing speed of Ta, high polishing speed ratio and reduced etching rate. Such technical idea are not expected from the disclosures of Kaufman et al '371. Though some elements may be generically and separately mentioned in Kaufman et al '371, Kaufman et al '371 does not teach or disclose the claimed elements and ranges and does not teach and disclose the unexpected improvements obtained thereby. Therefore, Applicants respectfully submit that Kaufman et al '371 suggests the present application.

For the above reasons, it is respectfully submitted that the subject matter of claims 1-14 is neither taught by nor made obvious from the disclosures of Kaufman et al '371 and it is requested that the rejection under 35 U.S.C. §103(a) be reconsidered and withdrawn.

#### **IV. Conclusion**

In view of the above, Applicants respectfully submit that their claimed invention is allowable and ask that the rejection under 35 U.S.C. §112 and the rejection under 35 U.S.C. §103 be reconsidered and withdrawn. Applicants respectfully submit that this case is in condition for allowance and allowance is respectfully solicited.

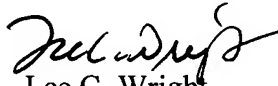
Amendment Under 37 C.F.R. §1.111  
Application No. 10/517,049  
Attorney Docket No. 043062

If any points remain at issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the local exchange number listed below.

If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,

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